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Indian Standard

SPECIFICATION FOR ELECTRICAL RELAYS FOR POWER SYSTEM PROTECTION

PART 2 REQUIREMENTS FOR PRINCIPAL FAMILIES

Section 1 All-or-Nothing Relays

(First Reprint AUGUST 1993)

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NEW DELHI 110002

Gr 7 *February* 1988

Indian Standard

SPECIFICATION FOR ELECTRICAL RELAYS FOR POWER SYSTEM PROTECTION

PART 2 REQUIREMENTS FOR PRINCIPAL FAMILIES

Section 1 All-or-Nothing Relays

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SPECIFICATION FOR ELECTRICAL RELAYS FOR POWER SYSTEM PROTECTION

PART 2 REQUIREMENTS FOR PRINCIPAL FAMILIES

Section 1 All-or-Nothing Relays

0. FOREWORD

0.1 This Indian Standard (Part 2/Section 1) was adopted by the Bureau of Indian Standards on 7 May 1987, after the draft finalized by the Relays Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 This standard is one of the series of standards being brought out to cover requirements of protection relays. General introduction to this series is given in IS : 3231 (Part 0)-1986*.

The standards published in the series so far are:

(Part 0) - 1986	General introduction and list of parts (*first revision*)
(Part 1/Sec 1) - 1986	General requirements, Section 1 Contact performance (*first revision*)
(Part 1/Sec 2) - 1986	General requirements, Section 2 Insulation test (*first revision*)
(Part 1/Sec 3) - 1986	General requirements, Section 3 High frequency disturbance test for static relays (*first revision*)
(Part 2/Sec 1) - 1987	Requirements for principal families, Section 1 All-or-nothing relays
(Part 2/Sec 2) - 1986	Requirements for principal families, Section 2 General requirements for measuring relays

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*Specification for electrical relays for power system protection : Part 0 General introduction and list of parts (*first revision*).

(Part 3/Sec 1) - 1987	Requirements for particular group of relays, Section 1 Non-specified time or independent specified time measuring relays
(Part 3/Sec 2) - 1987	Requirement for particular group of relays, Section 2 Dependent specified time measuring relays
(Part 3/Sec 3) - 1987	Requirement for particular group of relays, Section 3 Biased percentage differential relays

0.3 According to the classification on hierarchical basis [*see* IS : 3231 (Part 0)-1986*], this standard is a second level document.

0.4 This standard is prepared on the basis of IEC Publication 255-1-00 (1975) All-or-nothing electrical relays, issued by the International Electrotechnical Commission.

1. SCOPE

1.1 This standard (Part 2/Sec 1) specifies the performance requirements for all-or-nothing electrical protection relays and the parameters to be declared by the manufacturers of such relays. It also gives terminology of parameters and lists preferred values of relevant parameters, where these are not specified.

2. TERMINOLOGY

2.1 For the purpose of this standard, the definitions given in IS : 1885 (Part 9)-1986† shall apply.

3. RECOMMENDED VALUES

3.1 Energizing Quantities

3.1.1 *Recommended Rated Voltages Applied to the Relays* — The recommended values are equally applicable to the input energizing quantities and the auxiliary energizing quantities. The rated voltage shall be selected from the following values, unless otherwise agreed to between the manufacturer and the purchaser.

AC voltages (rms):

6, 12, 24, 42, 48, 100/√3, 110/√3, 120/√3, 100, 110, 115, 120, 127, 200, 220, 240, 380, 415, 500 V.

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*Specification for electrical relays for power system protection: Part 0 General introduction and list of parts (*first revision*).

†Electrotechnical vocabulary: Part 9 Electrical relays (*first revision*).

DC voltages :

6, 12, 24, 28, 48, 60, 110, 125, 220, 250, 440, 600 V.

NOTE — The underlined values are preferred values.

3.1.2 *Recommended Rated Currents* — There are no recommended rated values of energizing currents.

3.1.3 *Recommended Values of the Limits of the Operative Range of the Energizing Quantities* — The overall performance of a relay depends upon the operative range of the input energizing quantity and on the corresponding range(s) of any auxiliary energizing quantity(ies). These ranges may, therefore, be interdependent and particular consideration be given to such cases. The limits of the operative range of dc auxiliary energizing quantities shall be 70 and 110 percent of rated values.

NOTE — In certain instances, particularly in the case of energization from storage batteries, the limits of the operative range may necessarily differ from the standard values. In these circumstances, the manufacturer shall state the limits of operative range, for example, by writing more values at either side of the rated value, such as 80/125/140.

3.1.3.1 *Recommended values of the limits of the operative range of an input energizing quantity*

The recommended values of the limits of the operative range are related to two classes:

Class 1 — 80 to 110 percent of the rated value of the input energizing quantity (ies), and

Class 2 — 85 to 110 percent of the rated value of the input energizing quantity (ies).

NOTE 1 — Relays of Class 2 are intended to be used when associated with contactors or similar devices as included, for example, in IS : 2959-1975*.

NOTE 2 — When the input energizing quantity is a current, the operative range shall be indicated by the manufacturer.

Special case : In the particular case, where the limits of the operative range differ from the recommended values, the manufacturer shall state the limits of the operative range and the rated values.

Indication of the operative range :

a) Rated values shall be distinguished from the values of the limits of the operative range(s) by suitable means, for example, by underlining or by use of a special type face;

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*Specification for contactors for voltages not exceeding 1 000 ac or 1 200 dc (*first revision*).

b) The values shall be indicated in the manner shown in Table 1; and

c) The operative range class shall also be stated.

TABLE 1 EXAMPLES OF MARKING THE OPERATIVE RANGE OF AN INPUT ENERGIZING QUANTITY

(*Clause* 3.1.3.1)

		EXAMPLE	MEANING
Normal case Class 1 80 to 110 percent range Class 2 85 to 110 percent range	A single rated value	$\underline{110}$	Rated value 110 V Operative ranges 80 to 110 percent of 110 V (Class 1) 85 to 110 percent of 110 V (Class 2)
Only rated values shall be indicated	Two rated values (voltages applied to the same or to the different terminals)	$\underline{110}$	Operative ranges 80 to 110 percent of 110 V (Class 1) 85 to 110 percent of 110 V (Class 2) for the rated value 110 V
The operative range class shall be stated		$\underline{125}$	80 to 110 percent of 125 V (Class 1) 85 to 110 percent of 125 V (Class 2) for the rated value 125 V
Special case (*see* **3.1.3.1**)	A single rated value	110, $\underline{125}$, 140	Operative range 110 V to 140 V
Both rated and limit values shall be indicated	Two rated values (voltage applied to the same or to different terminals)	70, $\underline{110}$, 130 90, $\underline{125}$, 140	Operative ranges 70 V to 130 V for the rated value 110 V 90 V to 140 V for the rated value 125 V

3.1.3.2 *Recommended values of the limits of the operative range of auxiliary energizing quantities* — There are no recommended values. Limits shall be declared by the manufacturer and shall be such that the operative range complies with the requirements of this standard.

NOTE — The most severe combinations for the auxiliary energizing quantities and the input energizing quantities for preconditioning followed by pick up control shall be declared by the manufacturer.

3.1.4 *Pick up Classes* — Relays shall pick up and comply with the specification when energized at the lower limit of their operative range, after preconditioning corresponding to their pick up class as shown in Table 2, and with their input circuit(s) at their maximum operating temperature(s) corresponding to their duty class (*see* **4.2.4**).

NOTE — For relays in special applications, the manufacturer shall state the pick up values.

TABLE 2 PRECONDITIONING OF THE RELAYS CORRESPONDING TO PICK UP CLASSES

PICKUP CLASS	PRECONDITIONING		
	a	b	c
Energizing quantity (*see* **3.1.3.1**)	Rated value	Rated value	Upper limit of the operative range
Ambient temperature (*see* **3.4.2.1**)	Reference value	Upper limit of the nominal range	Upper limit of the nominal range

3.1.5 *Drop Out*

3.1.5.1 *DC relay* — The recommended limiting value of the input energizing quantity, at which the relay shall drop out, shall be not lower than 5 percent of the rated value, independent of polarity. Any value other than the recommended value may be admitted provided it is stated by the manufacturer or specified in the relevant standard.

3.1.5.2 *AC relays* — The recommended limiting value of the input energizing quantity, at which the relay shall drop out, shall be not lower than 15 percent of the rated value. The relay shall also drop out at zero (to take into account the effects of the eventual magnetic remanence). Any other value may be agreed subject to agreement between the manufacturer and the user.

3.2 Contact Circuits — The requirements of IS : 3231 (Part 1/Sec 1) - 1986*.

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*Specification for electrical relays for power system protection: Part 1 General requirements, Section 1 Contact performance (*first revision*).

3.3 Specified Times — There are no recommended rated values for the specified times; however, in the case of relays having a time-setting range, maximum values are proposed in Appendix A. There are no recommended rated setting ratios for specified time having a setting range.

3.4 Influencing Quantities and Factors

3.4.1 *Recommended Reference Values of Influencing Quantities and Factors* — The recommended reference values of influencing quantities and factors, and the associated test tolerances are given in Table 3.

NOTE — Special conditions of application or the nature of the relay itself may justify the use of non-recommended values. In such cases, the manufacturer shall state the reference values and tolerances.

3.4.2 *Recommended Values of the Limits of the Nominal Ranges of Influencing Quantities and Factors* — The values of the ambient temperature are given in **3.4.2.1** and those of the atmospheric pressure in **3.4.2.2**. The values of the other influencing quantities and factors are given in Table 4.

NOTE — The preferred values are to be assumed in the absence of statements to the contrary. Special conditions of application may necessitate the use of non-preferred values; such special values should, where possible, be selected from recommended values given in Table 4 and be stated by the manufacturer.

3.4.2.1 *Ambient temperature* — The preferred recommended temperature range is −5 to 45°C.

3.4.2.2 *Atmospheric pressure* — The preferred recommended range is 700 to 1 100 m bar.

Other recommended ranges for use in special applications (for example, aerospace) are :

a) 44 to 1 100 m bar, and

b) 1 to 1 100 m bar.

3.4.3 *Recommended Values of the Limits of Extreme Ranges of Influencing Quantities* — The limits of the extreme range of influencing quantities take into account installation, storage and transport conditions (*see* Appendix A).

NOTE — The preferred values are to be assumed in the absence of statements to be contrary.

3.4.3.1 *Ambient temperature* — The preferred recommended values of the limits are −25 and +70°C.

NOTE — Temperature is an example of those influencing quantities which may cause irreversible changes in relays.

3.4.3.2 *Other quantities and factors* — Extreme ranges of other influencing quantities are not specified. These extreme ranges are under consideration.

TABLE 3 RECOMMENDED REFERENCE VALUES AND TEST TOLERANCE OF INFLUENCING QUANTITIES AND FACTORS

(*Clause* 3.4.1)

INFLUENCING QUANTITY OR FACTOR (*see* NOTE 1 *and* APPENDIX A) (1)	REFERENCE VALUE (2)	TEST TOLERANCE (3)
Ambient temperature	27°C	±2°C
Atmospheric pressure	960 m bar	±100 m bar
Relative humidity	65 percent	−20 percent +10 percent
External magnetic induction	Zero	5×10^{-4} *T* in any direction
Position	As stated by the manufacturer	2° in any direction
Frequency	Either $16^{2}/3$ Hz or 50 Hz or 60 Hz or 400 Hz as stated by the manufacturer	±2 percent (*see* Note 5)
Waveform	Sinusoidal	Distortion factor 5 percent (*see* Note 2)
Alternating component in dc (ripple) (steady state) (*see* Note 3)	Zero	3 percent
Direct component in ac (steady state)	Zero	2 percent of peak value
Aperiodic transient component for specified time current relays	Zero	Under consideration
Input energizing quantity and auxiliary energizing quantity(ies) when they are regarded as influencing quantities relative to accuracy of specified times (and applied according to the duty class of the relay)	As respective rated values appropriate to the duty class	As stated by the manufacturer
Shocks and vibrations	*See* **9** and **12.10**	—
Industrial and other atmospheres	Under consideration	Under consideration
Setting time, if any	The upper limit of the setting range (*see* Note 4)	As stated by the manufacturer

NOTE 1 — The test may be carried out with values of the influencing quantities and factors other than the recommended reference values, provided the quantitative relationship between one or more influencing quantities and the value of the considered characteristic is known.

(*Continued*)

Notes to Table 3 — Contd

NOTE 2 — Distortion factor is the ratio between the rms value of the harmonic content obtained by subtracting the fundamental waveform a non-sinusoidal periodic quantity, and the rms value of the non-sinusoidal quantity. It is usually expressed as a percentage.

NOTE 3 — Alternating component in dc (that is, the ripple content of a dc supply, expressed as a percentage) is given by the following equation:

$$\text{Ripple content} = \frac{(\text{maximum instantaneous value voltage}) - (\text{minimum instantaneous value voltage})}{2 \times \text{dc component}} \times 100 \text{ percent}$$

dc component is the mean value of the waveform.

NOTE 4 — The upper limit of the setting range is the reference value for the indicated error, unless otherwise specified by the manufacturer. This reference value is taken as the 'conventional value', when determining the conventional error.

NOTE 5 — If the specified time does not depend on the frequency, the tolerances may be larger. However, when the relay time is frequency-dependent (for example, synchronous motor) and high accuracy is required, smaller tolerances may be necessary.

TABLE 4 RECOMMENDED VALUES OF THE LIMITS OF THE NOMINAL RANGES OF INFLUENCING QUANTITIES AND FACTORS

(*Clause* 3.4.2)

INFLUENCING QUANTITY OR FACTOR	NOMINAL RANGE
Ambient temperature	*See* **3.4.2.1**
Atmospheric pressure	*See* **3.4.2.2**
Relative humidity	To be stated by the manufacturer. There shall be neither condensation nor ice formation inside relay case
External magnetic induction	Preferred value 15×10^{-4} T in any direction or as stated by the manufacturer
Position	5° in any direction from reference position
Frequency	Reference value −6 percent, +10 percent or as stated by the manufacturer
Waveform	Under consideration
Alternating component in dc (ripple) (steady state)	$\leqslant$ 6 percent (*see* Table 3, Note 3)
Direct component in ac (steady state)	Under consideration
Aperiodic transient component for specified time current relays	Under consideration
Input energizing quantity*	Limits of the operative range
Input auxiliary energizing quantity(ies)*	Limits of the operative range(s)
Shocks and vibrations	*See* **9** and **12.10**
Industrial and other atmospheres	Under consideration

*Regarded as influencing quantity(ies) relative to accuracy of specified times (and applied according to the duty class of the relay).

3.5 Recommended Values of Intermittent Periodic Duty Parameters — The following recommended values shall be used for mechanical durability test and electrical load switching test, when practicable. Other values may be necessary, particularly for specified time relays. The manufacturer shall state the values to be used.

3.5.1 *Number of Cycles Per Hour* — Number of cycles per hour, equally distributed over the hour, shall be chosen from the following:

6, 30, 120, 600, 1 200, 1 800, 3 600, 6 000, 7 200, 12 000, 18 000, 36 000, 45 000, 72 000, 90 000, 108 000

NOTE — The underlined values are preferred values.

3.5.2 *Duty Factor* — The recommended duty factors shall be chosen from:

15, 25, 33, 40, 50 and 60 percent.

3.6 Dielectric Test Voltages and Impulse Voltage Tests — The requirements are specified in IS : 3231 (Part 1/Sec 2)-1986*.

4. PERMISSIBLE MAXIMUM TEMPERATURE

4.1 Permissible Maximum Temperatures of Relay Parts

4.1.1 *Insulation Materials* — The temperatures of insulating materials shall be not higher than permitted in IS : 1271-1985†. The stated limits of temperature may be exceeded in restricted parts of the insulating material, provided there is no apparent sign of damage and no apparent changes, in the characteristics.

NOTE — New insulating materials not yet included in IS : 1271-1985† may be used at other maximum temperatures if the same degree of safety is assured.

4.1.2 *Accessible External Parts* — The surface temperature shall not exceed 75°C or any other value stated by the manufacturer.

4.1.3 *All Other Parts* — The maximum temperature shall not cause visible signs of damage, permanent distortion or any other change in the component parts. Should a visible change occur, the manufacturer should be prepared to provide assurance that such a change in appearance would not affect the performance of the relay.

NOTE — Contact tips are excluded from the above temperature requirement.

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*Specification for electrical relays for power system protection: Part 1 General requirements, Section 2 Insulation test (*first revision*).

†Specification for thermal evaluation and classification of electrical insulation (*first revision*).

4.2 Conditions for Assessing Maximum Temperatures — Unless otherwise specified, the conditions given in **4.2.1** to **4.2.5** shall be fulfilled.

4.2.1 The relay shall be mounted in the normal position of use and, if necessary, in a manner stated by the manufacturer. When the relay is designed to be used in more than one position, the manufacturer shall state the less favourable position and the test shall be carried out in this position.

4.2.2 The ambient temperature shall be equal to the upper limit of their nominal range of temperature for operative range Class 1 relays and at the reference value for operative range Class 2 relays (*see* **3.1.3.1**).

4.2.3 All energizing circuits shall be at the upper limit of their operative ranges for operative range Class 1 relays and at the rated value for operative range Class 2 relays (*see* **3.1.3.1**).

4.2.4 At least half of the make contact circuits shall be loaded with their limiting continuous current.

4.2.5 The method of energization and duration shall be in accordance with the duty. The temperature rise with time for each duty is illustrated in Fig. 1.

5. ACCURACY OF THE SPECIFIED TIMES

5.0 A description of the various concepts relating to accuracy is given in Appendix C of IS : 3231 (Part 2/Sec 2)-1986*.

5.1 General

5.1.1 For specified time all-or-nothing relays, consideration of accuracy apply only to the specified time(s). Relays shall be in a new condition. All tests other than those for variations shall be made under the reference conditions.

5.1.2 The preconditioning of the relay, if any, for example whether the steady self-heating temperature had been reached before the test commenced, shall be indicated by the manufacturer.

5.1.3 The accuracy class index shall be stated for all specified time relays. The preferred accuracy class indices are 0·5, 1, 1·5, 2·5, 5, 7·5, 10 and 20, but the manufacturer may quote other values. When relevant, the manufacturer may also state, for a given relay, the reference mean error (calibration error), consistency, reference limiting error and/or limits of variations. The conventional value for determining the conventional error shall be the reference setting value. For relays with an assigned error applicable to operating time, the maximum permissible error of the specified operating time shall be expressed as either a percentage of the time setting value or a percentage of the time setting value together with a fixed maximum time error (where this may exceed the percentage value), whichever is greater.

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*Specification for electrical relays for power system protection: Part 2 Requirements for principal families, Section 2 General requirements for measuring relays.

5.1.4 For the determination of variations, the mean error shall be the mean of ten measurements, unless otherwise specified.

5.2 Methods of Determining the Errors Relating to the Specified Time

5.2.1 *Test Conditions Relating to the Auxiliary Energizing Quantity(ies)* — The manufacturer shall state whether the initial value of each of the auxiliary energizing quantities is the rated value or zero. For the determination of errors relating to the specified time, the final value shall be zero or the rated value, as stated by the manufacturer.

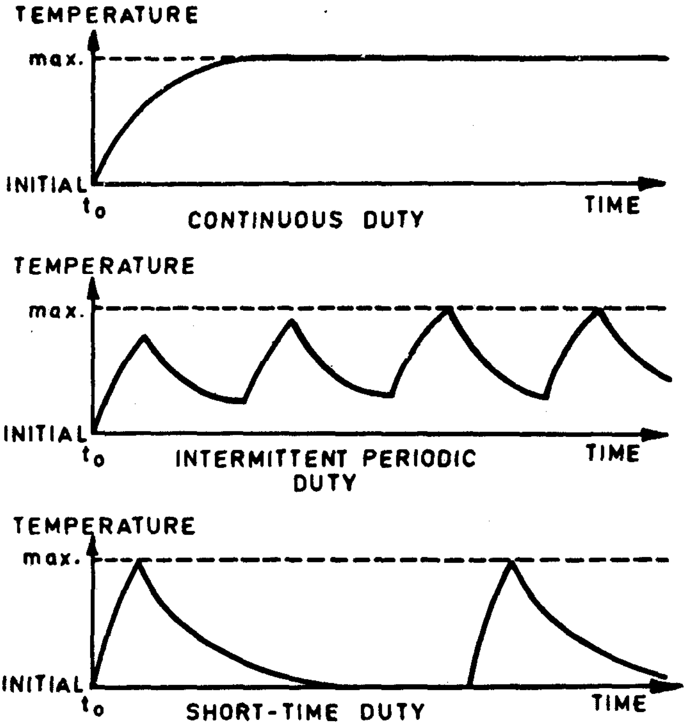

Fig. 1 Temperature-Rise for Various Duties

5.2.2 For the determination of reference limiting errors and reference consistency [*see* Appendix C of IS : 3231 (Part 2/Sec 2)-1986*].

5.3 Method of Determining the Variations Relating to the Specific Time

5.3.1 The manufacturer shall state whether the initial value of the auxiliary energizing quantity is the rated value or zero. The final value of the auxiliary energizing quantity shall be zero or any value within the nominal range of the auxiliary energizing quantity.

6. MECHANICAL DURABILITY

6.1 The manufacturer shall state the number of cycles which the relay can perform with no load in the contact circuits and when tested under the conditions stated in **12.7**.

7. CONTACT PERFORMANCE

7.1 The requirement given in IS : 3231 (Part 1/Sec 1)-1986†, shall be applicable.

8. RATED BURDEN (POWER)

8.1 The value of the rated burden and the tolerance shall be indicated by the manufacturer For relays, the burdens of which vary with the position of their moving parts or for other reasons, the manufacturer shall state at least two values, that is, the maximum and the minimum burdens, and shall indicate the corresponding conditions.

The burden shall be stated for each of the input and auxiliary circuits.

The burden shall be expressed at rated values, as indicated below:

a) For dc relays, in watts; and

b) For ac relays, in voltamperes. In this case, a value of the power factor shall be given.

9. SHOCK AND VIBRATION REQUIREMENTS

9.1 Classification — Relays shall be classified with respect to their ability to withstand the mechanical shocks and vibration likely to be experienced in a particular location or type of use in accordance with Table 5.

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*Specification for electrical relays for power system protection: Part 2 Requirements for principal families, Section 2 General requirements for measuring relays.

†Specification for electrical relays for power system protection: Part 1 General requirements, Section 1 Contact performance (*first revision*).

TABLE 5 CLASSIFICATION OF RELAYS FOR MECHANICAL SHOCK AND VIBRATION

(*Clause* 9.1)

MECHANICAL STABILITY CLASS INDEX (1)	NORMAL USE (2)	TYPICAL EXAMPLE OF APPLICATION (3)
S1	Sensitive relays which may require external protection from mechanical shock or vibration or both	Sensitive measuring relays requiring external anti-vibration mounting
S2	Relays suitable for normal industrial conditions of shock and vibration	Stationary locations free from shock and vibration in excess of these mentioned in **9.3** and heavily damped swing panels
S3	Relays intended for more onerous conditions than S1 and S2	Shipboard, traction and un-damped swing panels

NOTE 1 — Class S1 relays may be used in Class S2 situations either by virtue of special mounting techniques or by the use of special circuitry, for example, by the use of time lags.

NOTE 2 — S3 conditions would normally be agreed between the manufacturer and the purchaser in the light of specific application requirements.

9.2 Mechanical Shock Requirements — Under consideration.

9.3 Vibration Requirements

9.3.1 Relays falling into classification S2 shall be subjected to a resonance search vibration test as specified in **12.10.2**. During the test no unduly severe reasonance or relay malfunction shall occur within the nominal frequency range of the input energizing quantity(ies) or in the ranges which are mo-multiples of this range.

NOTE — Where the size of the relay renders it impractical to test it as a whole, it may be tested as functional sub-units, as agreed to between the manufacturer and the purchaser.

9.3.2 If a malfunction occurs at any other frequency within 10 to 300 Hz range, acceleration shall be decreased to 0 and then increased to $0{\cdot}15\ g_n$ at the frequency(ies) at which the malfunction occured. No malfunction shall occur at $0{\cdot}15\ g_n$.

9.3.3 The $0{\cdot}15\ g_n$ acceleration level is subject to a maximum peak amplitude of 0·039 mm (*see* Fig. 2).

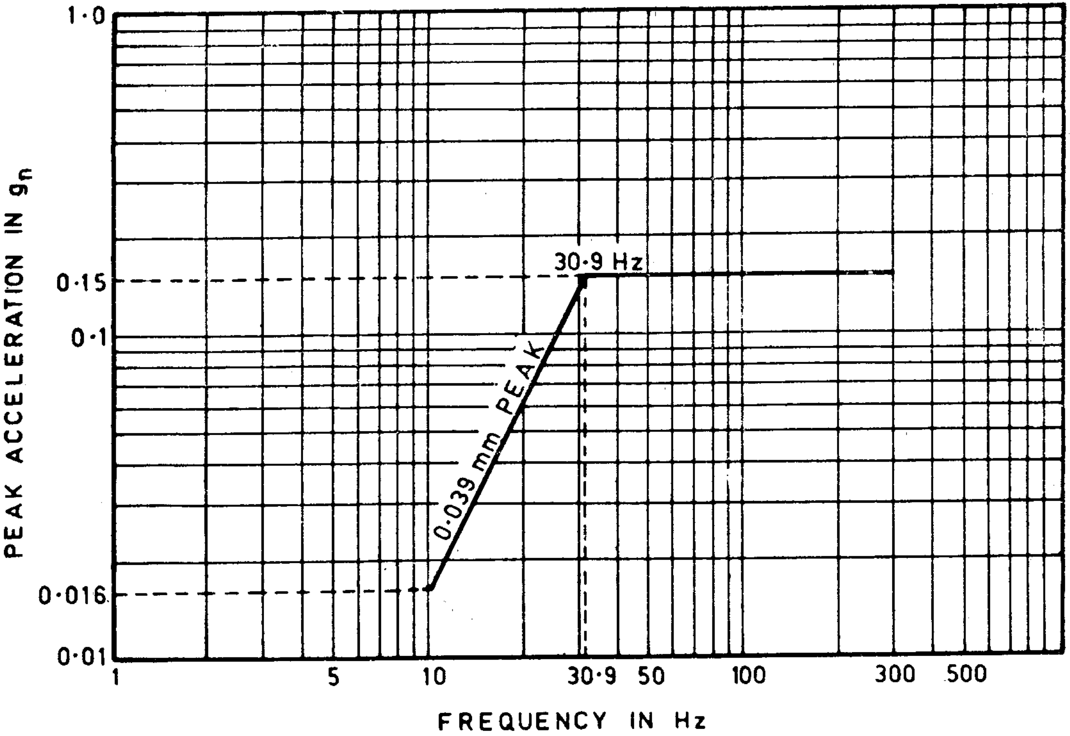

FIG. 2 MAXIMUM TEST ACCELERATION LEVELS FOR RESONANCES NOT HARMONICALLY RELATED TO NOMINAL FREQUENCY RANGE

9.3.4 Relay malfunction shall be detected as specified in **12.10.2.1.** Relays failing to comply with these requirements are deemed to fall within Class S1. The requirements for vibration testing of Class S3 relays shall be the subject of special agreement between the manufacturer and the purchaser because they are dependent upon specific operational environments.

9.3.5 The test shall be carried out with the relay under reference conditions.

9.3.6 The tests shall be carried out with the following values of energizing quantities (auxiliary and input) applied to the appropriate circuits.

a) Auxiliary energizing quantity(ies) — Rated value(s), and

b) Input energizing quantity(ies) — As specified in Table 2 of IS: 3231 (Part 2/Sec 2) 1986*.

NOTE — For static relays or sub-units or relays which contain no moving parts the relay or sub-unit may be tested energized, as agreed to between the manufacturer and the purchaser.

9.3.7 Prior to the test, the accuracy of the relays shall be checked under reference conditions. At the conclusion of the test, the accuracy shall be re-checked and the variation in error from the initial measurement, shall not exceed half the assigned error declared by the manufacturer.

10. DATA AND MARKING

10.1 General

10.1.1 The following data (with indication of units) shall be made available by the manufacturer:

a) Manufacturer's name, identification code or trade-mark;

b) Type designation, serial number or detail sheet number;

c) Rated value of the energizing quantities (*see* **3.1.3.1**);

d) Values of the limits of the operative range(s) of the input energizing quantity if they differ from the recommended values, the operative range class (*see* **3.1.3.1**) and the pick up class (*see* **3.1.4**);

e) The limits of the operative range(s) of the auxiliary energizing quantities;

f) Frequency for ac or the symbol ⎓ for dc;

g) Contact data;

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*Specification for electrical relays for power system protection: Part 2 Requirements for principal families, Section 2 General requirements for measuring relays.

h) Rated value or setting range of the specified time; either for pick up, or for drop out and for corresponding accuracy class index;
j) Data to permit identification of the coil(s) and energizing circuits;
k) Value of the resistance of winding(s);
m) Value of the resistance of winding(s);
n) Dielectric test voltage(s);
p) Mechanical durability expressed in number of cycles;
q) Mounting position;
r) Data to permit the suitable connection of the relay, including polarity;
s) Accessories, if essential to the relay performance;
t) Data concerning the earthing of metal parts;
u) Duty; and
w) If the relay has any unusual feature or requirement, it shall be marked prominently with this symbol ⚠ to indicate that reference to the detail specification is essential.

10.2 Requirements for marking — Data (a), (b) and, if applicable (w) shall be marked on the relay by a durable method so that they are legible with the relay mounted as in service. Data(c), (f), (h) and (j), if not implicit in (b), shall be marked on the relay without necessarily being visible, with the relay mounted as in service.

11. CLASSIFICATION OF TESTS

11.1 The tests are classified as type tests, routine tests and special test(s).

11.2 Routine Tests — The following shall constitute the routine tests:

a) Measurement of accuracy of specified time under reference condition (**5** and **12.6**),
b) Pick up (**12.1**),
c) Drop out (**12.2**), and
d) Dielectric tests (**12.3**).

11.2.1 If so desired by the purchaser, values of rountine tests results shall be supplied by the manufacturer on mutually agreed terms.

11.3 Type Tests — The following shall constitute type tests:

a) Measurement of accuracy of specified time under reference condition (5 and **12.6**),
b) Pick up (**12.1**),

c) Drop out (**3.1.5** and **12.2**),
d) Dielectric tests (**12.3**),
e) Impulse voltage tests (**12.4**),
f) Temperature rise test (**12.5**),
g) Mechanical durability (**12.7**),
h) Contact performance (**12.8**),
j) Rated burden (**12.9**),
k) Vibration test, and
m) High frequency disturbance test.

11.3.1 Unless otherwise agreed at the time of ordering, it shall suffice that the manufacturer may furnish type test certificates as evidence that type tests have been made in accordance with this standard. The manufacturer shall make available the type test results together with appropriate drawings and records of any relevant alteration which may have been made to the relay subsequent to the type tests.

11.4 Special Tests — These are normally made only at the request of the purchaser and are subject to the agreement of the manufacturer. They may take the form of a test which is normally recognized only as a type test, requirements additional to those specified for a particular test within standard, or a test not at present specified in this standard.

12. TEST METHODS

12.1 Pick Up

a) All relays shall be tested for their operating values by gradually increasing the characteristic quantity of the relay until the relay just operates,
b) The relay should operate within the pick up classes stated in **3.1.4**, and
c) The pick up value shall be less than the value corresponding to the lower limit of the specified operating range in **3.1.3.1**.

12.2 Drop Out — The drop out value shall be checked as follows:

a) the input energizing quantity is suddenly reduced from its rated value to the limit stated in **3.1.5**
b) with all values of the auxiliary energizing quantity(ies) within their operative range(s) and
c) with any latching or holding action in operative.

12.3 Dielectric Tests — Provisions of IS : 3231 (Part 1/Sec 2)-1986* shall apply.

12.4 Impulse Voltage Tests — Provisions of IS : 3231 (Part 1/Sec 2)-1986* shall apply.

12.5 Temperature Rise of Energizing Circuits — The manufacturer shall demonstrate compliance with **4.1** and, if necessary, shall prove that the relay characteristics mentioned in **4.1** are not changed as a result of prolonged use under the conditions laid down in **4.2**.

When determining temperature, it is assumed that thermal equilibrium is reached when the temperature does not vary by more than 0·5°C in 10 minutes.

12.6 Accuracy — The requirements given in **5** shall be satisfied.

12.7 Mechanical Durability — To facilitate testing of mechanical durability, a small lead, defined by the manufacturer in terms of current and voltage, may be applied to the contact circuits (for example, for operation counters).

12.7.1 The test conditions are as follows:

a) Relay mounted as for normal service;

b) Input and auxiliary energizing quantities at their rated values;

c) Influencing quantities and factors other than the setting value under reference conditions [*see* **12.7.1** (c)];

d) Number of cycles per hour and duty factor, as stated by the manufacturer (*see* **3.5**); and

e) Setting, for adjustable-time relays at the setting which gives the most severe conditions for mechanical durability.

Throughout the tests of mechanical durability, the relay shall comply with the drop out requirements of **3.1.5**.

12.7.2 At the conclusion of the test, the following requirements shall be complied with by the relay.

a) The mechanical conditions of the relay shall be such that it is capable of carrying out its designed function throughout its setting range at least once at the maximum value and once at the minimum value of the operative ranges of the input and auxiliary energizing quantities. During these latter tests, the contact circuit(s) shall carry the maximum currents claimed by the manufacturer;

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*Specification for electrical relays for power system protection: Part 1 General requirements. Section 2 Insulation test (*first revision*).

b) No value of the absolute error shall exceed, with a given confidence level, twice the reference limiting error; and

c) The insulation level should not fall below 0·75 times the value of the dielectric test voltage specified for the new relay.

NOTE — Any routine maintenance or replacement claimed by the manufacturer is permissible during the tests, but no other parts may be replaced.

12.8 Contact Performance — The requirements of IS : 3231 (Part 1/ Sec 1)-1986* shall apply.

12.9 Rated Burden (Power)

12.9.1 The value of the rated burden shall be checked under the following conditions:

a) the relay being cold (that is, without self-or-extraneous heating);

b) the influencing quantities and factors under their reference conditions; and

c) the given circuit being energized at its rated value, all other circuits being unenergized, unless otherwise stated.

When the burden varies significantly according to the position of the moving parts or for other reasons, measurement shall be carried out under the two extreme conditions.

12.10 Shock and Vibration Tests

12.10.1 *Mechanical Shock Tests* — Not specified.

12.10.2 *Vibration Tests*

12.10.2.1 *General requirements*

a) the relay under test shall be vibrated along each of its three major axes over the frequency range of 10 to 300 Hz at an acceleration of 0·5 g. The actual vibration amplitude corresponding to this acceleration may be determined from the following formula:

$$a_{pk} = 4\,\pi^2 f^2\, x_{pk}$$

where

a_{pk} = peak value of acceleration,
x_{pk} = amplitude of vibration, and
f = frequency of vibration.

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*Specification for electrical relays for power system protection: Part 1 General requirements, Section 1 Contact performance (*first revision*).

b) Malfunction of the input circuit(s) (contact or otherwise) shall be checked using a follower relay or device. The function of the follower device is to indicate if the relay under test has malfunction by picking up (p.u.) or dropping off (d.o.), one preferred following response times are:

  1) 10 ms, and

  2) 0·3 ms; and

c) If a 10 ms relay is used as a follower, any movement of its contacts should be taken to indicate malfunction. Flags or other operational indicators shall not change their initial state during the vibration test. Table 6 indicates the conditions of the follower device both during the test and for indication of output circuit operation.

TABLE 6 VIBRATION TEST CONDITIONS

[*Clause* 12.10.2.1(c)]

Type of Relay	Type of Output Circuit	Test Condition Input Energizing Quantity(ies)	Contact Position	Function of Follower Device for Indication of Output Circuit Operation	Condition of Follower During Test for Correct Operation
All-or-nothing p.u. All-or-nothing d.o.	Make	Unenergized	Open	p.u.	De-energized
All-or-nothing p.u. All-or-nothing d.o.	Make	Energized at rated value	Closed	d.o.	Energized
All-or-nothing p.u. All-or-nothing d.o.	Break	Unenergized	Closed	d.o.	Energized
All-or-nothing p.u. All-or-nothing d.o.	Break	Energized at rated value	Open	p.u.	De-energized

12.10.2.2 *Particular test requirement*

a) *Mounting of relays* — The relay should be fastened to the vibration generator table by its normal means of attachment. Care should be taken with the positioning of any additional straps or stays. Any connections to the equipment shall be arranged so that they impose no more restrain or mass then they would when the relay is installed in its operational position. The relay shall be mounted such that the gravitational force acts on it in the same relative direction as it would in normal use. Vibration amplitude and acceleration shall be measured at or as near as possible to, one of normal fixing points on the relay under test. Care should be taken to ensure that the relay under test is not significantly affected by magnetic fields generated by the vibration system if these are greater than the maximum permitter reference level of 0·5 mT.

b) *Vibration system* — The characteristics of the vibration generator and fixture, when loaded for the tests, shall be such as to produce a basic motion of sinusoidal form, so that the fixing points of the relay under test move substantially in phase end in straight parallel lines.

c) *Vibration level tolerance* — The actual vibration level in the required direction shall correspond to the requirements of **9.3.2**, **9.3.3** and **12.10.2.1**; and at each fixing point, where measurement is specified, the tolerance shall be as given in Table 7.

TABLE 7 VIBRATION LEVEL TOLERANCES

[*Clause* 12.10.2.2(c)]

FREQUENCY	IN THE FREQUENCY WHERE DISPLACEMENT AMPLITUDE IS SPECIFIED	IN THE FREQUENCY WHERE ACCELERATION AMPLITUDE IS SPECIFIED
	percent	percent
Not exceeding 150 Hz	± 25	± 15
Exceeding 150 Hz	—	+ 25

NOTE — Where it is difficult to achieve the figures quoted at some discrete frequency range, for example, for large specimens and/or at high frequencies, it is possible that a wide tolerance or an alternative method of assessment will be necessary.

d) *Frequency Tolerances* — Measurement of frequency for resonance determination shall be made with a tolerance of ±0·5 Hz or ±1 percent whichever is the greater, other frequency tolerances shall be ±1 Hz up to 50 Hz and ±2 percent over 50 Hz.

APPENDIX A

(*Clause* 3.3 *and* 3.4.3)

EXPLANATORY NOTES ON SPECIFIED TIME AND INFLUENCING QUANTITIES

A-0. The basic characteristics of an all-or-nothing relay, which essentially determine its performance, when picking up and dropping out, are functions of the energizing quantity(ies) and the possible variations in the values of such quantities, and of the influencing quantity(ies) and the possible variations in the values of such quantities.

Some definitions are restricted solely to non-specified time all-or-nothing relays, others solely to specified time all-or-nothing relays. These restrictions are indicated, if relevant, in the heading of the definitions.

A-1. Note on Specified Time — Specified time all-or-nothing relays have same fundamental characteristics as non-specified time all-or-nothing relays as regards pick up and drop out. They must, moreover, comply with the requirements relating to the accuracy of the specified time(s) as given in Appendix C of IS : 3231 (Part 2/Sec 2)-1986*.

It has not been possible to standardize rated values of the specified time. For specified time all-or-nothing relays having a setting range of the specified time, it is, however, recommended that a value in Table 8 be adopted whenever possible, as the maximum setting value of the specified time.

TABLE 8 SPECIFIED TIME

Milliseconds (ms)	1	3	6	10	15	30	60	100	300	600
Seconds (s)	1	3	6	10	15	30	—	—	—	—
Minutes(min)	1	3	6	10	15	30	—	—	—	—
Hours (h)	1	3	6	12	—	—	—	—	—	—
Days (d)	1	—	2	3	—	—	—	—	—	—

A-2. Note on Influencing Quantities — In order that the performance of relays may be assessed and compared, it is necessary that tests be made at prescribed values of the influencing quantities, these values being the reference values.

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*Specification for electrical relays for power system protection: Part 2 Requirements for principal families, Section 2 General requirements for measuring relays.

A-2.1 When all the influencing quantities have their reference values, the relay is said to be under 'reference conditions'. Since the effects on relay operation of small changes in influencing quantities are presumed to be negligible, and since there may be practical difficulties in maintaining precisely the reference value, small tolerances about each reference value are permitted in **3.4.1** to allow for possible measurement and control errors when reproducing reference conditions of influencing quantities.

It is emphasized that, during testing, the different influencing quantities should be varied one at a time within the nominal ranges; that is, a single influencing quantity will be varied throughout its range whilst all the other influencing quantities are maintained at their reference values (subject to the tolerances indicated in this standard). It is virtually impossible, in a general standard of this nature, to predict the cumulative effect of simultaneous changes of a number of influencing quantities, each within its own range.

The reference values, together with their associated tolerances, constitute the standard test conditions for all-or-nothing relays. Nevertheless, for particular applications, supplementary specification requirements may be necessary; these would generally be in the spirit of this standard. (*Example*: relays intended to be used continuously at very high ambient temperatures).

The specified performance of a relay is related to a given set of reference conditions. In practice, however, the relay must be capable of being used under conditions which are less restricted than the reference conditions. The ranges within which an all-or-nothing relay is intended to be usable are called 'nominal ranges of the influencing quantities' and their limits are given in **3.4.2**.

Finally, a relay may be subjected to even more extreme conditions, during, for example, installation, storage and/or transport. These are referred to as the limits of extreme ranges of influencing quantities and within these specified limits (but beyond the limits of the nominal range), the relay is merely required to be capable of withstanding the effects of the change of influencing quantities without suffering any degradation which would not revert to normal when the reference conditions are restored. The relay is not required to operate correctly under these extreme conditions, since it is not envisaged that such conditions should arise during service.

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